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(पहला पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR CONSTRUCTION OF CROSS DRAINAGE WORKS

(First Revision)

ICS 93.160

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

October 2000 **Price Group 3**

AMENDMENT NO. 1 SEPTEMBER 2005
TO
IS 9913 : 2000 CODE OF PRACTICE FOR CONSTRUCTION OF CROSS DRAINAGE WORKS

(First Revision)

(*Page* 2, *clause* 9) — Substitute the following for the existing clause

'9 **MATERIALS**

9.1 Concrete and its ingredients such as cement, pozzolana, coarse and fine aggregates, water and chemical mixtures shall conform to the relevant requirements of IS 456

9.2 Stone and Brick Masonry

Stone masonry including the stone and mortar shall conform to the relevant requirements of IS 8605 For brick masonry, in addition to common burnt clay building bricks conforming to IS 1077, pulverized fuel ash – lime bricks conforming to IS 12894 and burnt clay flyash bricks conforming to IS 13757 shall be used Masonry mortar shall conform to IS 2250

9.3 Reinforcement and Prestressing Steel Reinforcement and Prestressing Steel shall conform to the relevant requirements of IS 456

Other Materials — Other materials like wire crates, etc, shall be as per the relevant design requirements '

(*Page* 5, *clause* **13.2**) — Add a new subclause **13.3** as indicated below

'**13.3** Pond ash conforming to IS 3812 (Part 1) can also be used as backfill material '

(*Page* 6, *Annex* **A**) — Substitute 'IS 456 2000' *for* 'IS 456 1978' and the corresponding title as 'Plain and reinforced concrete — Code of practice (*fourth revision*)'

Substitute the following title of IS 1343 1980 for the existing

Code of practice for prestressed concrete (*fourth revision*)'

Substitute 'IS 1888 1982' *for* 'IS 1888 1971' and the corresponding title as 'Method of load test on soils (*second revision*)'

Substitute 'Structures' *for* 'structure' in the main title of IS 3370

Substitute 'IS 3370 (Part 2) 1965' *for* 'IS 3370 (Part 2) 1967'

Substitute the following in the title of IS 7784 (Part 1) 1993

'design' *for* 'designing'.

Delete the following standards from the list

'383 1970 Coarse and fine aggregates from natural sources for concrete (*second revision*)', and 'IS 9103 1979 Specification for admixtures for concrete'

Add the following Indian Standards along with their titles in Annex A at the appropriate place

IS No	*Title*
'IS 1077 1992	Common burnt clay building bricks — Specification (*fifth revision*)
IS 2250 1981	Code of practice for preparation and use of masonry mortars (*first revision*)
IS 3812 (Part 1) 2003	Specification for pulverized fuel ash for use as pozzolana in cement, cement mortar and concrete
IS 8605 1977	Code of practice for construction of masonry in dams
IS 12894 2002	Specification for pulverized fuel ash-lime bricks (*first revision*)
IS 13757 1993	Specification for burnt clay flyash building bricks'

(WRD 13)

Reprography Unit, BIS, New Delhi, India

Cross Drainage Works Sectional Committee, WRD 17

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cross Drainage Works Sectional Committee had been approved by the Water Resources Division Council

Cross-drainage works are structures which are constructed to negotiate an aligned carrier channel over, below or at the same level of a drainage of another carrier channel

For the purpose of this standard, cross drainage works include aqueducts, super passages, canal syphons, level crossings and syphon aqueducts

For general features of design of cross drainage works, reference may be made to IS 7784(Part 1)

Part 2 of IS 7784 deals with specific design requirements for various types of cross drainage works

In the light of experience gained while applying the provisions of the earlier version of this standard to practical situations, changes have been incorporated in this revision It includes guidelines for construction of aqueducts where the superstructure is prestressed

There is no ISO standard on the subject This standard has been prepared based on indigenous manufacturers' data/practices prevalent in the field in India

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 1960 'Rules for rounding off numerical values (*revised*)' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard

Indian Standard

CODE OF PRACTICE FOR CONSTRUCTION OF CROSS DRAINAGE WORKS

(First Revision)

1 SCOPE

The construction of a cross drainage works of a large size incorporates numerous activities, each of which, in turn may have to be planned and executed considering several practical aspects It may not be possible to cover all such situations in a single standard This standard, therefore gives broad guidelines for the planning and construction of cross drainage works

2 REFERENCES

The standards given in Annex A contain provisions which through reference in this text constitute provisions of this standard At the time of publication, the editions indicated were valid All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 4410(Part 15/Sec 5) shall apply

4 SITE SURVEYS

4.1 Before taking up the execution, a site plan to a scale of 1 in 500 with contours at suitable intervals shall be prepared covering an area not less than 200 m all around the proposed structure and allied works if any High Flood Level (HFL) and Normal Flood Level (NFL) shall be marked Sites for stores, bins storage space for aggregates and other materials, batching and mixing of concrete workshop disposal areas etc, should all be planned and marked on the site plan along with the outlines of the respective structures

4.2 Permanent benchmarks shall be established in concrete/masonry on firm ground on either flank of the drain which the structure is proposed to be constructed, well above the high flood levels and well beyond the canal embankment margins These benchmarks shall be accurately connected with the benchmark used originally for survey and investigations

4.3 The permanent benchmarks shall be located so as to be at least 50 m away from the route which is likely to be used by machinery/other vehicles for the formation of canal embankment or for constructions of the cross drainage structure

5 TRIAL PITS BORING — TESTING OF SOIL SAMPLES

5.1 Static penetration tests shall be carried out at all important components of the proposed structure, that is abutments, piers, wing walls, etc Trial borings should be made on abutments, wing walls and on piers at suitable intervals and be carried out up to suitable depth below foundation level Soil samples should be taken and tested for obtaining data for use in design of structures Sub soil water level (minimum and maximum) should be ascertained

5.2 If clay seams are met with at or below the foundation level, undisturbed samples shall be taken and tested for engineering properties including plasticity index, effective stress parameters (cohesion and angle of shearing resistance), total soluble solids and settlement/swelling characteristics In case of soils with low bearing capacity, plate load bearing tests as prescribed in IS 1888 shall also be conducted

5.3 It is preferable to avoid locating the structure in the following areas, if

a) A fault plane exists in the foundation rock mass in the vicinity of the structure and is oriented unfavourably from the point of view of stability of structure,

b) Calcareous or swelling type soils are present either in the joints in rock foundations or in the vicinity of structure to fall within the load bearing area, and

c) Soils having low bearing capacity or high settlement characteristics occur

5.4 If the structures are located in places mentioned in 5.3(a), (b) and (c), detailed studies for the treatment to improve foundation conditions should be carried out unless the location of the structure/canal alignment can be economically changed

6 PRELIMINARY WORKS AND DIVERSION ARRANGEMENTS

6.1 Centre line or axis line pillars for references shall be constructed firmly on either flank and above HFL Reference pillars for layout of work shall also be suitably located

6.2 Area for the disposal of excavated materials shall be defined and marked

6.3 Water requirement and its quality should be assessed and supply arrangements to meet this requirement should be made

6.4 Adequate arrangements for power, including backup arrangements during power failure shall be made for dewatering and for other construction activities

6.5 Quarries for construction materials and locations of other required materials should be identified and demarcated Possibility of use of alternative materials should be fully considered to avoid interruption during construction

6.6 Requirements for screening, crushing, washing of aggregates, batching and mixing plants should be assessed and arrangements made accordingly

6.7 Diversion arrangements to suit the construction schedule should be planned and incorporated in the schedule on the basis of discharge data The scope will depend on whether construction operations are planned on seasonal or annual working

6.8 The excavation of the canal may be stopped on either side of the drainage crossing (measured from high flood mark) as suggested below to facilitate making river/drain diversion of roads and to provide adequate space for work-platforms, stacking materials and equipment and for minor shift in the alignment of the canal/structure required, if any

a) for rivers/drains having discharges less than 100 cumecs — 150 m,

b) for rivers/drains having discharges 100 to 300 cumecs — 300 m, and

c) for rivers/drains having discharges more than 300 cumecs — 500 m

6.9 Temporary roadway for the movement of machinery across the river/drain may be formed beyond the work area of the upstream or the downstream protection work of the structure, so that it may not interfere with the execution of the work

6.10 Sufficient quantity of construction material and equipment shall be stored/stacked on either flank well above HFL Storage of materials should be as per IS 4082

7 RING BUND AND DEWATERING ARRANGEMENTS

7.1 Where a ring bund or a coffer dam is to be formed, the top level should be kept well above the normal flood level as per provisions of IS 9795(Part 1)

7.2 Various alternatives for dewatering, for example, battery of well points, shallow tube wells, surface pumping or gravity flow depending on the permeability of the strata and the topography should be considered and most suitable one selected. In case the pumped water is to be discharged through an artificial or natural drain, adequate slopes should be ensured

8 CONSTRUCTION SCHEDULE

8.1 Construction schedule shall be carefully prepared For carrying out construction efficiently, modern techniques of management like Program Evaluation and Review Techniques (PERT) and Critical Path Method (CPM) of construction scheduling may be employed for major works

8.2 In case of small and non-perennial drains, the entire portion of sub-structure can be tackled in one stretch and the work should be completed in one season For major works the construction may have to be planned in more than one working season In such cases the structure should be brought in a safe level before the onset of monsoons The schedule for removal of construction machinery and equipment before the onset of monsoon should be suitably worked out

8.3 If the size of the structure is large and it cannot be completed in one working season, its substructure may be divided into such segments which can be completed in one working season so that dewatering and clearing of silt/muck deposited during rains can be obviated

8.4 Where cut off walls or pile lines are specified in the drawings, the same are to be executed and protected adequately from incidental scour due to floods occurring during the construction period

9 MATERIALS

9.1 Cement

The cement used shall be any of those specified in IS 456

9.2 Aggregates

9.2.1 All aggregates shall conform to IS 383

9.2.2 Coarse and fine aggregates shall be batched separately as per design requirements of the concrete mix

9.3 Other Materials

Other materials like bricks, stones, wire crates, etc, should be as per relevant design requirements

9.4 Water

Water used for mixing and curing should conform to the requirements given in IS 456

9.5 Admixtures for Concrete

9.5.1 Admixtures may be used with the approval of the engineer-in charge after adequate testing

9.5.2 The admixture shall conform to IS 9103

9.6 Reinforcement and Prestressing Steel

Reinforcement and prestressing steel shall conform to the requirements of IS 456

10 FOUNDATION AND FLOOR CONCRETE

10.1 Where feasible, the foundation concrete shall be laid in single pour If it is not possible to lay concrete in one pour the floor shall be divided into compartments and provided with suitable construction joints The concrete should be laid in layers of 300 mm or so and sufficient precautions shall be taken to ensure proper bonding of pours The surface shall generally be sand blasted or thoroughly cleaned and layers of cement slurry of sufficient consistency shall be laid before placing subsequent pours If a layer is left unfinished at the end of the season, the dowels and seals may also be provided as required

10.2 If for any reason concreting is to be stopped in the middle of the bay, it shall be left in steps not less than 150 mm in depth When the work is resumed, the surface of the old concrete shall be roughened well by chiselling, thoroughly cleaned and a layer of cement grout worked well into the surface of the old concrete before new concrete is laid over it

10.3 Wearing coat concrete as specified shall be laid while the base concrete is still green and not fully set

10.4 In case of concreting of thick section arrangements for heat dissipation shall be made

10.5 For consolidating concrete, immersion vibrators as per IS 3558 shall be used

10.6 Well Foundations

10.6.1 Foundations supporting the super structure of large works located in deep water channels shall comprise liberally dimensioned caissons The outer diameter shall be large and preferably not less than 6 m with the minimum thickness of caisson wall as one metre

10.6.2 For caissons resting on rock, proper square seating should be ensured

10.6.3 The soundness of bottom plug should be tested by dewatering the well by 5 m below the surrounding water level and checking the rise of water The rate of rise should be less than 100 mm/h In case the rate is higher, suitable remedial measures shall be taken

10.6.4 The concreting of bottom plug shall be done by tremie or other approved method and not by skip box

10.7 Pile foundations are generally not provided in case of aqueducts Piles, where unavoidable, should not be provided within the flood zone of the river with deep scour

11 PIERS, ABUTMENTS & SUPER STRUCTURE

11.1 Piers and abutments may be solid, or cellular type The minimum thickness of walls shall be 600 m The construction joints should be kept to the minimum and should be avoided in the splash zone

11.2 Trestle type frames for substructure shall not be allowed within the flood zone of the river

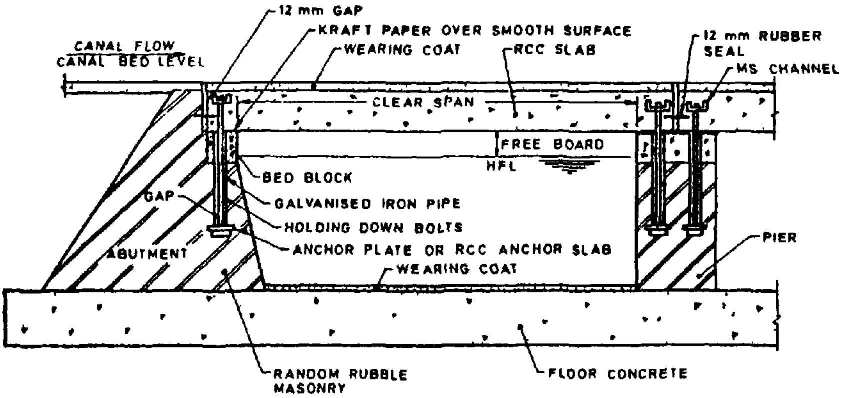
11.3 Where abutments, piers or barrels are to be constructed in stone masonry, the facing shall be coursed rubble and the hearting in random masonry In case of brick masonry, selected bricks or concrete blocks of sufficient strength mix moulded on vibrating table shall be used in the masonry In case of concrete construction sufficient care shall be taken for smooth finish of formed surface and proper bonding between successive lifts should be ensured For large works construction joints may be provided and adequate precautions taken to ensure a good bond with fresh concrete If necessary prior laboratory trial of bonding method should be carried out

11.4 In case of brick masonry construction the surface should be plastered with 1 3 cement sand mortar where velocity exceeds 2 m/s otherwise these should be cement pointed In case of stone masonry, permissible velocity may be higher Granite may be adopted in piers and abutments for higher velocities

11.5 For spans, less than 3 0 m, the top of the masonry abutment and piers should be provided with suitably designed concrete bed block and two coats of asphaltic paints applied over it before laying roof slab Where the roof slab is not monolithic with concrete abutment/pier and laid separately two coats of asphaltic paint/graft paper/appropriate bearing material should be placed over it before laying the roof slab of the drainage barrel For large spans the designers arrangement of bearings should be adhered to (*see* Fig 1)

11.6 Placing of Bearings

Bearings are provided so that the bearing stresses induced in the substructure are within permissible



NOTE — HFL and free board shall not apply for the provisions contained in 12

FIG. 1 DETAILS OF HOLDING DOWN BOLTS

limits and also to allow for certain movements due to temperature variation, rotation due to deflection and vertical movements due to sinking of supports.

Bearings are of two types:

a) Expansion bearings free to move longitudinally and also free to rotate, and

b) Fixed bearings free to allow rotation. Particular design of bearings to be adopted depends upon type of structure, type of supports and length of span.

For small spans, no special bearings are usually provided. A thick layer of kraft paper or tarfelt is inserted. This is sufficient for small longitudinal movements.

For spans up to 10 m, a plate bearing is sufficient. This bearing has a line contact and permits tilting in one direction and movement in the direction of span.

For spans above 10 m usually mild steel roller and rocker bearings are provided. In a span, one end is provided with a fixed bearing and the other end with a roller bearing.

11.7 Wherever practical an arched masonry roof can be considered instead of R C slabs.

12 HOLDING DOWN BOLTS

12.1 Suitably designed holding down bolt (*see* IS 5624) should be used when the HFL is higher than the bottom of the top slab of the barrel and the abutments and piers are not monolithic with slab to safeguard against blowing up. Even if the pressure is not large, nominal bolts should be provided.

12.2 Care should be taken that the threads of the bolts are not damaged during the construction by providing dummy nuts fixed flushed with the top of the bolts.

12.3 Soon after the masonry around the bolt is completed, hot molten asphalt should be poured in the gap around the bolt, keeping the bolt in the centre of the gap in a perfectly vertical position. Care should be taken to see that no stone chips enter the gap around the bolt.

12.4 All the bolts should be connected by a channel section of specified size and the nuts tightened fully. Threads of either the bolts or the nuts should not get worn out.

12.5 The channel sections should be placed in the top portion of the RCC slab and grouted with non shrinking concrete (Fig. 1).

13 BACK FILLING

13.1 Back filling behind the abutments and wing walls shall be done in layers of 100 mm and compacted well with frog hammers maintaining the required moisture prescribed for getting optimum density in the vicinity of the wall. If masonry construction and back filling is to be done concurrently, back filling shall be done after adequate minimum period of 7 days. In case of R C walls, 14 days should elapse in construction of each step and back filling should be done before raising the next step.

13.2 Abutments, return and wing walls should be provided with weepholes as mentioned in IS 7784

(Part 1) staggered at suitable intervals and with necessary inverted filters behind the abutment or walls. In case of relatively impervious back fill, drainage layers at suitable levels connected to the filters may be necessary. The filters should be laid simultaneously along with the back filling operations.

14 REINFORCED CEMENT CONCRETE CONSTRUCTION

14.1 Relevant provisions of IS 456 and IS 3370 shall apply to the cross drainage works.

14.2 Concreting of the RCC slab or trough in a bay shall normally be done in the direction in which it spans.

14.3 In canal syphons, ribs of nominal size as prescribed in IS 7784 (Part 2/Sec 3) should generally be provided at suitable intervals all round the barrel.

14.4 Vertical walls of the trough for the box shall be cast in one pour as far as possible. Otherwise, water-tight construction joints shall be provided.

14.5 The shuttering of the bottom slab and walls shall not be removed before 21 days from casting of the vertical walls.

15 PRESTRESSED CONCRETE IN SUPER STRUCTURE

15.1 Where the super structure of a cross drainage work is to be constructed as a prestressed concrete structure, the relevant provisions of IS 1343 and IS 3370 (Part 3) should be followed.

15.2 All prestressed steel, sheathing, anchorages and sleeves or coupling, etc, should conform to the design requirements. All steel and accessories should be protected during transportation, handling and storage. For wires up to 5 mm dia, coils of about 1.5 m and for wires above 5 mm, coils of about 2 m diameter without breaks and joints shall be obtained from manufacturers. The prestressing steel, sheathing and other accessories should be stored under cover to protect from rain, ground dampness and ambient atmosphere if it is likely to be aggressive. Storage at site must be kept to the absolute minimum. Data in respect of modulus of elasticity, relaxation loss at 1 000 h, minimum ultimate tensile strength, stress strain curve, etc, shall necessarily be obtained from the manufacturers in order to ensure the design values.

15.3 Joints of all sheathing-should be water tight. A collar may be provided at the joints. Special attention should be paid to the junction at the anchorage end, where sheathing should tightly fit on to the protruding trumpet end of anchorages and thereafter sealed with heat shrink tape to make it water proof.

15.4 Grouting

15.4.1 For grouting, duly approved and recognized procedures should be followed.

15.4.2 The mixing of the grout should be done such that the grout mix is maintained in a homogeneous colloidal state during the entire grouting process.

15.4.3 The temperature of the grout, after accounting for the ambient temperature of the structure, shall not exceed 30°C.

16 CONCRETING AT CONSTRUCTION JOINTS

16.1 Where formwork is fixed for the next lift it should be inspected to ensure that no leakage can occur from fresh concrete.

16.2 The slab should be completed from joint to joint in one continuous operation. When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints neat cement slurry shall be applied on the surface before it is dry. For horizontal joints the surface shall be covered with a layer of mortar about 10 to 15 mm thick comprising of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing of the concrete. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of aggregate. At the surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and well rammed against the old work, particular attention being paid to corners and close spots. Thereafter work should proceed in the normal way. The cement grout/slurry used should be of the same mortar that is used in the concrete of trough.

17 WATER STOPS

Water stops where necessary shall be provided as given in IS 7784 (Part 1).

18 PRECAUTIONS AGAINST FLOOD DAMAGES DURING CONSTRUCTION

18.1 When a completed portion of the structure is likely to be subjected to the on slaught of floods, it should be adequately protected by appropriate methods like sand bags, stones, piles, lean concrete , masonry, etc.

18.2 For safeguarding syphon barrels against floatation during construction stage in regions of high spring level, an opening in the ends of the barrel should be provided with pipes to allow filling in of the barrels by ground water. The safety of the barrel should be checked for construction condition when completed but not loaded with earth filling The openings should then be closed and concreted in one operation

19 APPROACH CHANNELS AND TAIL CHANNELS

The approach channels and tail channel shall be excavated to the designed bed level before commissioning of the structure

20 CLEARING OF SITE

As soon as the structure is completed, the barrels/troughs/ventways as well as the river bed on the up- stream and downstream of the structure should be cleared of all debris, excavated spoil, shuttering and other construction material to provide clear passage for river/drain flows

21 MISCELLANEOUS

Care should be taken to see that the catch drains formed along the borrow pits located on either side of the approaches are not to be led into the river/drain near to the structure These may be connected to the river/drain well beyond the protection works

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No	*Title*
383 : 1970	Coarse and fine aggregates from natural sources for concrete (*second revision*)
456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)
1343 : 1980	Code of practice for prestressed concrete
1888 : 1971	Method of load tests on soils (*first revision*)
3370	Code of practice for concrete structure for the storage of liquids
(Part 1) : 1965	General requirements
(Part 2) : 1967	Reinforced concrete structures
(Part 3) : 1967	Prestressed concrete structures
(Part 4) : 1967	Design tables
3558 : 1983	Code of practice for use of immersion vibrators for consolidating concrete (*first revision*)
4082 : 1996	Stacking and storage of construction materials and components at site — Recommendations (*second revision*)
4410 (Part 15/Sec 5) : 1992	Glossary of terms relating to river valley projects Part 15 Canal structures, Section 5 Cross drainage works (*first revision*)
5624 : 1993	Foundation bolts (*first revision*)
7784 (Part 1) : 1993	Code of practice for designing of cross drainage works Part 1 General features (*first revision*)
7784 (Part 2/Sec 3) : 1996	Code of practice for design of cross drainage works Part 2 Specific requirements, Section 3 Canal syphons (*first revision*)
9103 : 1979	Specifications for admixtures for concrete
9795 (Part 1) : 1981	Guidelines for the choice of the type of diversion works Part 1 Cofferdams

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Amendments Issued Since Publication

Amend No	Date of Issue	Text Affected

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